Space Weather Technical Forecast

Issued on Sunday 16 February 2025 at 01:14 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1/R1/Active electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has fallen to Low in the last 24 hours, with peak flare a C3.6 at 15/1936UTC from a region beyond the western limb.

There are currently ten sunspot regions on the visible disc. AR3990 in the southeast, nearing centre disk, has a large central asymmetric spot surrounded by peripheral spots, most of which are small, with signs of a tenuous delta perhaps developing near the central spot. AR3992 in the southwest continues and opening and fading trend. AR3994 near south centre disk is a small and apparently unremarkable region, yet was the source of a number of flares and perhaps faint CMEs on 14 Feb. AR3995 unusually remains within the southern coronal hole/s, splitting it in two. Finally AR3996 continues to rotate into view, with a relatively long and perhaps increasingly complex nature gradually becoming evident . All other spots are relatively simple with only little changes observed.

A CME from a filament eruption in the northeast of the disc was observed at 15/0107 UTC.

Solar Wind / Geomagnetic Activity: Solar winds as measured at L1 by ACE, showed an ongoing connection to a fast wind, showing an overall rise from elevated levels of 550km/s to strong levels of around 630km/s by the end of the period. Density was generally below average. The IMF showed a weakening trend from moderate (8-9nT) to weak (3-5nT). The north-south component varied between +6 and -8nT, also on a weakening trend over time. Phi angle was mostly negative (Toward the Sun). The net result of the above solar wind measures was Unsettled to Active geomagnetic activity, with a peak of G1/Minor storm (Kp 5) for two intervals 15/0900-1159UTC and 15/2100-2359UTC.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 persisted at Background levels.

High energy electron flux (greater than 2MeV) at GOES16 was at diurnally high levels, peaking at 4740pfu at 15/1530UTC, before falling below the active threshold overnight. The associated 24-hour fluence remained below the 1e8 Active threshold, with the 16/0000UTC observation being 8.36e7 integrated pfu.

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Four-Day Space Weather Forecast Summary

Solar Activity: Low to moderate activity is expected with a chance of isolated M-class flares, probably from AR3990 or AR3996.

Solar Wind / Geomagnetic Activity: Several faint CMEs from 14/15 Feb bring a chance of glancing impacts between day 1-3 (Feb 16–18), with a low risk of some of these CMEs merging.

Coronal hole fast winds from CH14/- are elevated, and anticipated to remain relatively steady through day 1 (Feb 16), with a slow decline back to background by the end of day 3 or day 4 (Feb 18-19).

Predominantly Unsettled to Active geomagnetic conditions are expected throughout, with a chance of G1/Minor geomagnetic storm (Kp 5) intervals due to coronal hole influences or glancing CMEs. By the end of day 3 (18 Feb) solar wind speeds and current CME risks are expected to diminish, with geomagnetic activity falling back to Quiet to Unsettled levels (Kp 0-3).

Energetic Particles / Solar Radiation: High energy proton flux is forecast to persist at Background levels, with a marginally increasing Slight Chance of a S1 event given the westward progression of current active regions.

The high energy electron flux is generally expected to become diurnally high each day, with a daily chance of reaching Active fluence, though confidence is low, and the forecast may prove volatile until CH14 and CH15 rotate closer to the western limb.

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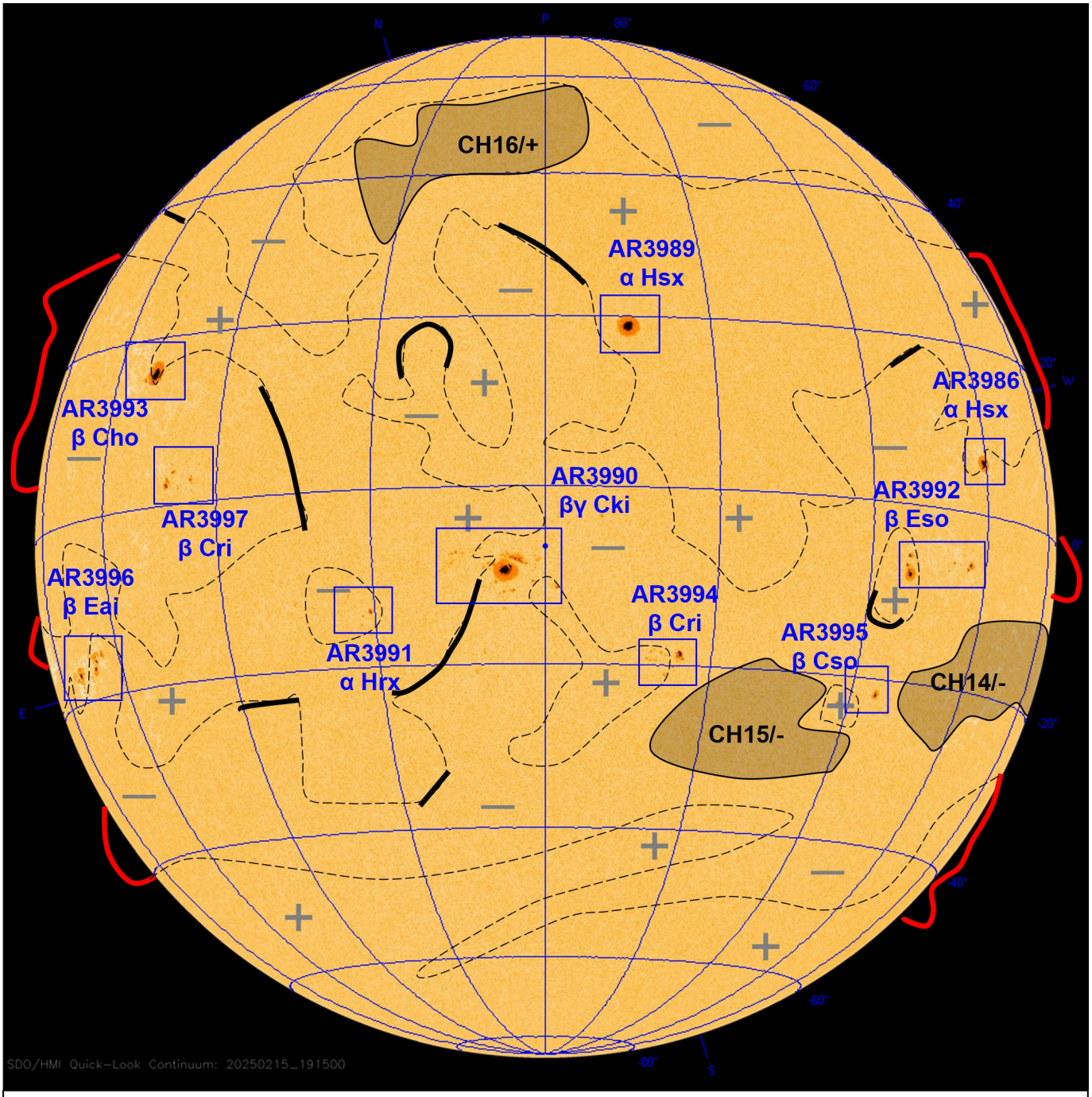
Figure 1: Solar synoptic map valid 15/1915UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

Several faint CMEs were observed leaving the Sun on February 14th, likely originating from AR3990 or AR3994. Additionally, a CME from a filament eruption in the northeast of the disc was observed at 15/0107 UTC. Confidence in all of these CMEs remains low due to the absence of clear dimming in imagery and the influence of nearby coronal hole fast winds. The analysis is further complicated by suspected far-sided events. As a result, there is a chance of glancing impacts between day 1-3 (Feb 16–18), with a low risk of some of these CMEs merging.

Coronal hole fast winds from CH14/- continue, but the coronal hole is now split, with its rearward portion designated as CH15/-. Despite this, a sustained period of elevated-strong winds is expected, with a seamless transition from CH14/- into CH15/-. Solar wind speeds are anticipated to remain relatively steady through day 1 (Feb 16), with a slow decline back to background by the end of day 3 or day 4 (Feb 18-19). This forecast is supported by MOSWOC ENLIL, which shows only minor deviations related to the previously mentioned glancing CMEs.

Predominantly Unsettled to Active geomagnetic conditions are expected throughout, with a chance of G1/Minor geomagnetic storm (Kp 5) intervals due to coronal hole influences or glancing CMEs. By the end of day 3 (18 Feb) solar wind speeds and current CME risks are expected to diminish, with geomagnetic activity falling back to Quiet to Unsettled levels (Kp 0-3). The main forecast uncertainty is perhaps the duration of the enhancement, although the peak magnitude is not expected to exceed G1 levels.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	50	40	30	20
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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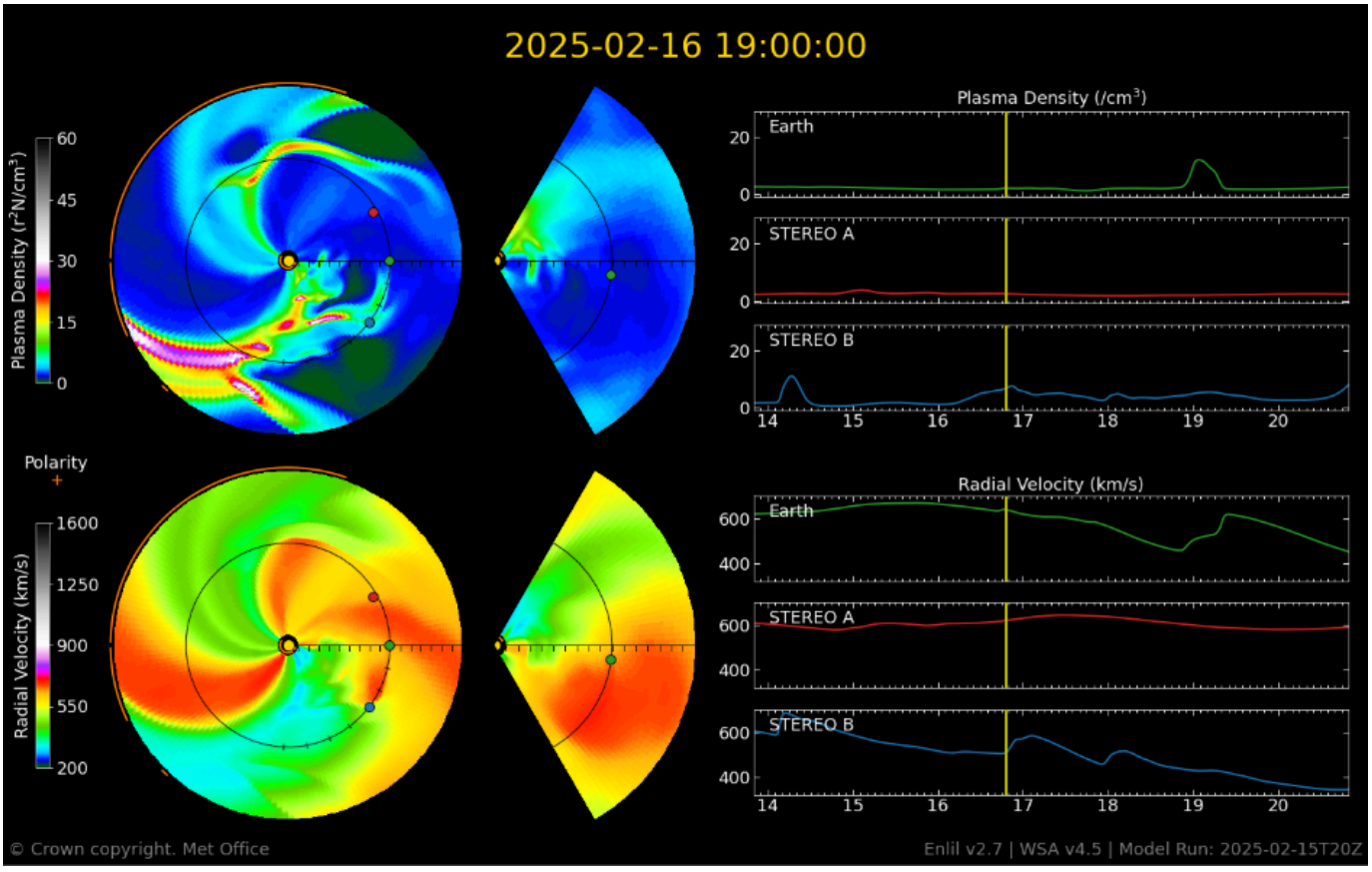
Figure 2: MOSWOC ENLIL



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Radio Blackouts - X-Ray Flares

Solar activity has fallen to Low in the last 24 hours, with peak flare a C3.6 at 15/1936UTC from a region beyond the western limb.

There are currently ten sunspot regions on the visible disc. AR3990 in the southeast, nearing centre disk, has a large central asymmetric spot surrounded by peripheral spots, most of which are small, with signs of a tenuous delta perhaps developing near the central spot. AR3992 in the southwest continues and opening and fading trend. AR3994 near south centre disk is a small and apparently unremarkable region, yet was the source of a number of flares and perhaps faint CMEs on 14 Feb. AR3995 unusually remains within the southern coronal hole/s, splitting it in two. Finally AR3996 continues to rotate into view, with a relatively long and perhaps increasingly complex nature gradually becoming evident . All other spots are relatively simple with only little changes observed.

A chance of moderate activity with isolated M-class flares possible, probably from AR3990 or AR3996, with a flat trend through the period.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	50	50	50	50
Very Active	R3-R5 (X Class)	No	5	5	5	5

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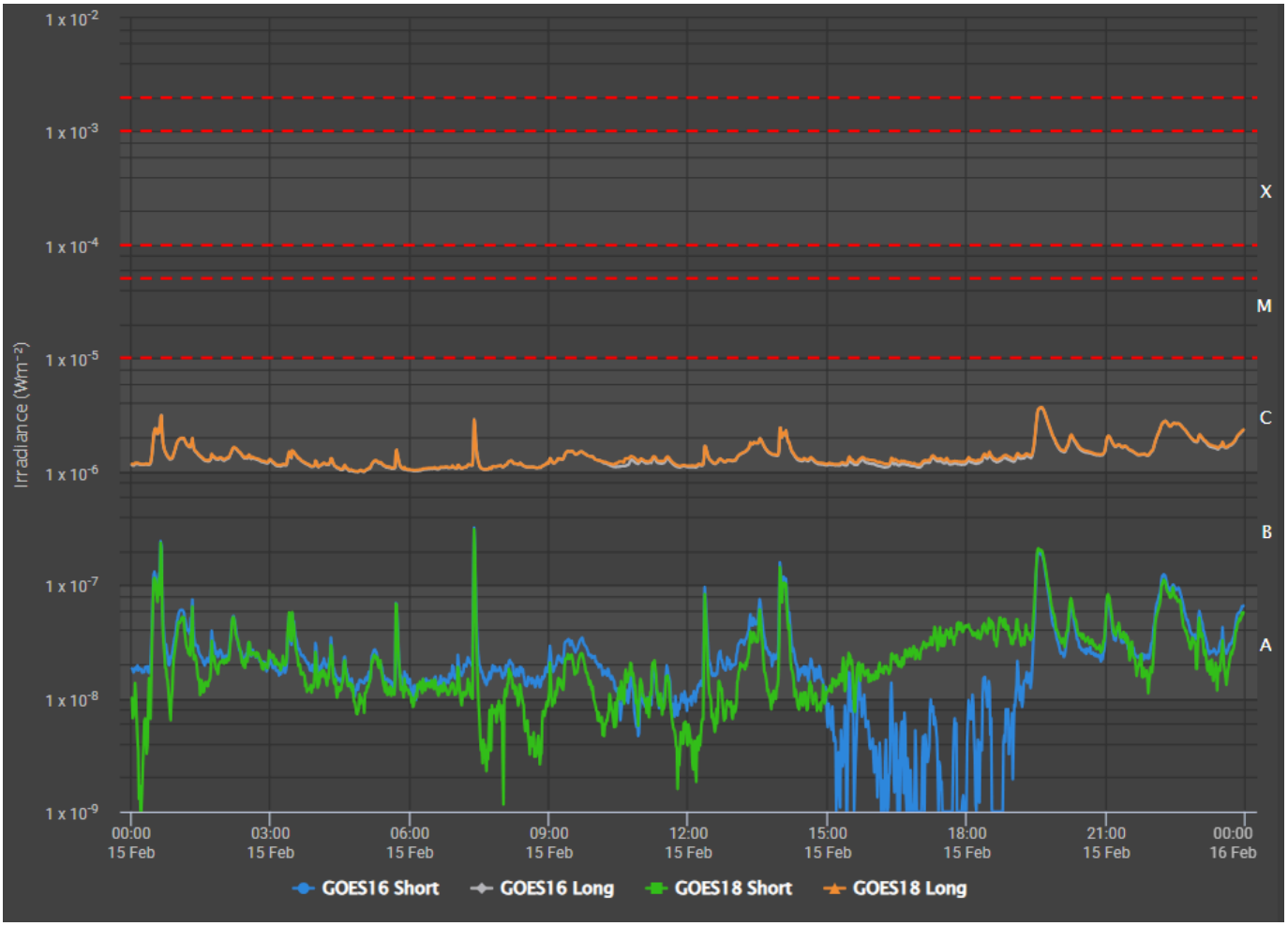
Figure 3: 24 hour X-ray trace.



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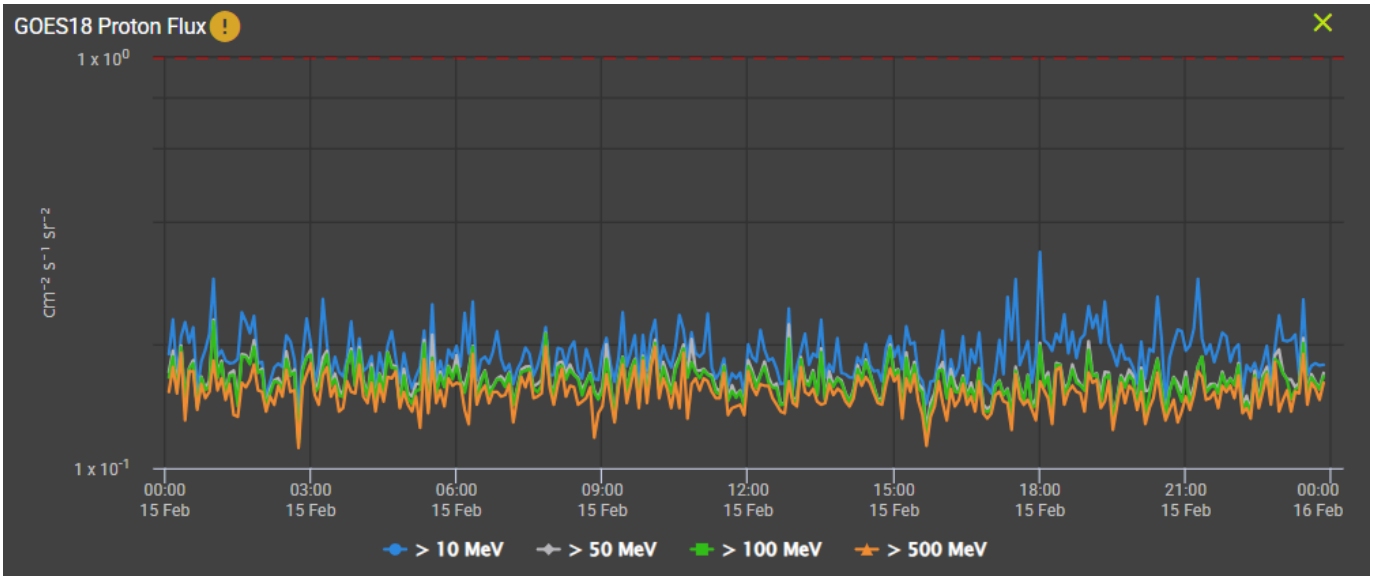
Solar Radiation Storms (High Energy Protons)

GOES18 proton flux is most likely to persist at Background levels, but with a slowly increasing daily Slight Chance of enhancement from any notable flares from AR3990 as it rotates into the western hemisphere.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: 24 hour proton trace.



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High Energy Electrons (≥ 2MeV)

Confidence in the high energy electron forecast remains low due to competing factors affecting flux levels. The sustained solar winds and geomagnetic activity from CH13/- and CH14/- has been sufficient to charge but not significantly compress the Van Allen belt and its High electron populations at GEO. This has led to diurnal peaks at high electron flux levels. A similar trend is likely to continue with occasional drop-outs to Normal Background flux still probable within the minima of the diurnal cycle or should any geomagnetic enhancements occur. In time as the coronal hole high speed stream eases, flux levels may become more persistently high. On the other hand possible glancing CMEs may also act to clear a portion of electrons from GEO.

An associated day-on-day chance of Active electron fluence is possible. MOSWOC REFM reacted to the previous days high levels of flux and has now run-away with the forecast, though recurrence has electron fluence levels much lower than anticipated, with reality most likely somewhere in the middle of these.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	50	50	50	50
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 5: MOSWOC REFM Fluence forecast/observations/recurrence.

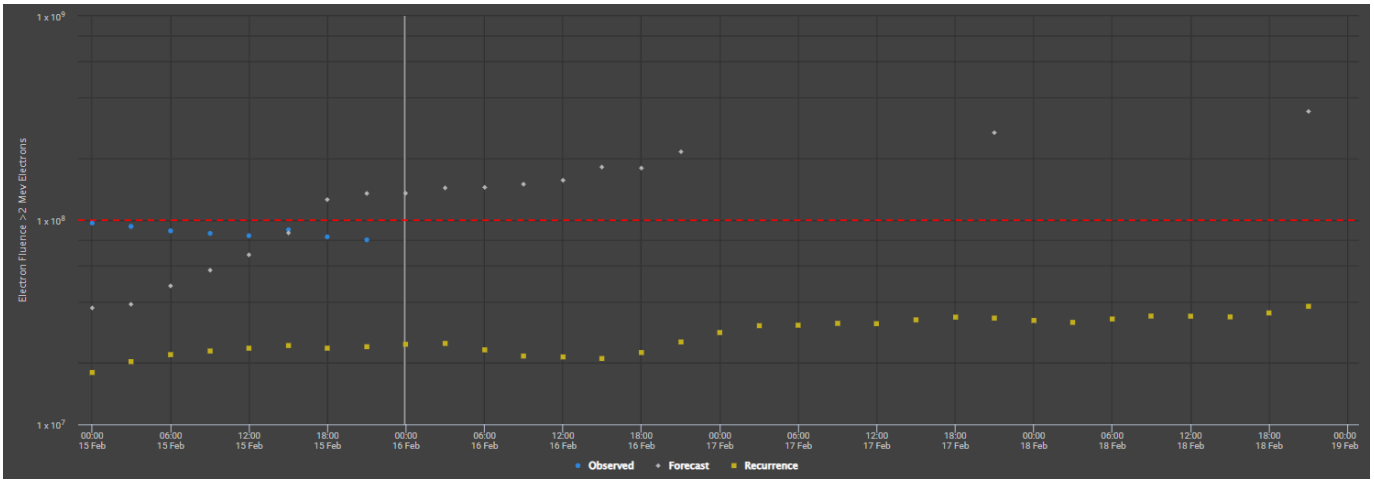

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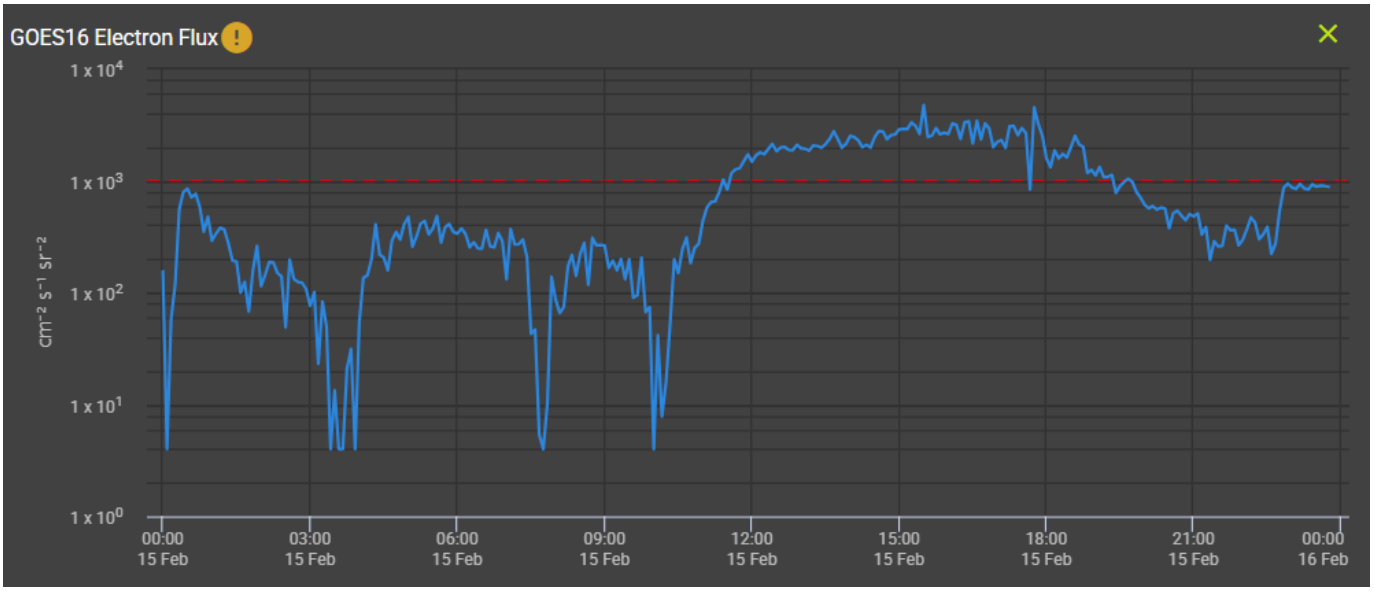
Figure 6: 24 hour electron flux trace.



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